ARIZONA DEPARTMENT
OF
ENVIRONMENTAL QUALITY

Douglas A. Ducey
Governor

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Director

via e-mail

September 6, 2017
FPU18-041

Ms. Catherine Jerrard
AFCEC/CIBW
706 Hangar Road
Rome, NY 13441

RE: WAFB – ADEQ comments - *Revised Draft Final Addendum #2, Remedial Design and Remedial Action Work Plan for Operable Unit 2, Revised Groundwater Remedy, Site ST012, Former Williams Air Force Base, Mesa, Arizona*; prepared for Air Force Civil Engineer Center (AFCEC/CIBW), Lackland AFB, TX; prepared by Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec), Phoenix, AZ; document dated August 8, 2017.

Dear Ms. Jerrard:

Arizona Department of Environmental Quality (ADEQ) Federal Projects Unit (FPU) and ADEQ contractor UXO Pro, Inc. reviewed the above referenced document. ADEQ's comments are presented below and on following pages.

General Comments

GC 1: Pre-EBR (enhanced bioremediation) mass estimates in the revised draft final document are not reliable for the selection and design of enhanced bioremediation (EBR). The mass estimates presented in Table 2-1 for the Pre-SEE LNAPL and in Table 2-6 for the estimated COCs remaining Pre-EBR are not reliable for the selection and design of EBR as described in the comments and responses to responses to comments on the Amec mass estimate spreadsheet of March 23, 2017. The majority of previous comments provided by ADEQ remain applicable to Appendix A of the Revised Draft Final Addendum #2. In particular, the assumed light non-aqueous phase liquid (LNAPL) removal percentages from steam enhanced extraction (SEE) are not justified by any field data or citations to peer-reviewed literature. The removal assumptions were further compromised by the lack of measures for mass removal from individual vertical zones during SEE. The LNAPL mass and constituent fractions are the sole parameters upon which the EBR design relies for specifying the mass of sulfate to be injected. An upward revision of the mass may render the approach untenable.

GC 2: Design of EBR in the upper water bearing zone (UWBZ) is not based on any field biological data. Amec did not conduct an EBR field test in the UWBZ in support of EBR design as specified in the Final Remedial Design and Remedial Action Work Plan (Amec, 2014). The rising groundwater level did not

enter the UWBZ until about 1998; therefore, any groundwater biological data collected from this period and earlier is not applicable to the UWBZ.

GC 3: The timeframe of remediation for the site and attainment of remedial action objectives (RAOs) by EBR is not supported by calculations or estimates. The modeling described in Section 2.3 and Appendix F was adequate for the design of sulfate distribution. However, estimates for the time of remediation (TOR) were not provided. The underlying mechanisms of sulfate reduction were not evaluated in the Revised Draft Final Addendum #2. Instead, as described in Section 3.2.2, a rate for sulfate utilization was calculated based on the estimated utilization rate from the field test in the lower saturated zone (LSZ). This approach does not yield an estimate for the time to attain remedial goals and no estimate for the utilization rate is available for the UWBZ. The inadequacy of this approach was described in previous ADEQ comments and responses on the Draft Final Addendum #2 and in the TOR memorandum prepared by Praxis Environmental Technologies, Inc. and the responses to Amec's evaluation of the TOR memorandum.

GC 4: Subsurface temperatures remain highly elevated and may be too high to support normal soil bacteria capable of hydrocarbon degradation and sulfate-reduction.

Specific Comments

1. **Section 2.4, Lines 534-535:** Revise text to reflect that Appendix D data only represents site conditions prior to SEE, not after SEE. The EBR Pilot Test, as reported in Appendix D, was conducted in 2014 before SEE was initiated. As stated in Line 449 (Section 2.3), SEE resulted in "dynamic" changes to the subsurface. Thus, the data presented in Appendix D reflects only pre-SEE conditions, not current site conditions. As such, this data does not support the EBR phase of this project.

2. **Section 2.4, Lines 547-552:**
    a. Please justify the sulfate-reducing bacteria (SRB) population. The data presented in Appendix D actually suggests a more moderate SRB population, ranging only in the 104-106 range, with most samples measuring at the lower end of that range. As a total percentage of the whole microbial population, SRBs accounted for only 0.48-4.13% of the whole community.
    b. Please justify the 1998 geochemistry study data relevancy. The "previous study" provided as a reference as to why SRBs are currently the dominant form of hydrocarbon biodegradation at the site is a 1998 geochemistry study of minimal quality and poor information assessment. Regardless of the quality of the study, the data is 18 years old and is profoundly out of date. At a location such as ST012, which has been exposed to "dynamic" and extreme geochemical manipulation, it is scientifically unsound to suggest that this data is relevant to current site conditions.
    c. Line 551. The document should be edited to reflect the following findings. Line 551 asserts that contaminant assimilation has been tested and was reported in the referenced 1998 BEM document. A review of this document did not find any such tests to have been conducted but instead only found summaries of an earlier (1986) study which performed basic terminal electron acceptor (TEA) assessments at the site. It is noteworthy that the referenced document did conclude that "mineralization of BTEX compounds is occurring through the microbially mediated processes of aerobic respiration, denitrification, iron reduction, sulfate reduction, and methanogenesis" (BEM, 1998, Appendix A, Section 4.2.3). Although sulfate-reduction was reported to account for 80% of assimilation capacity, this was based only on indirect groundwater chemistry parameters and not direct microbial analyses. This data also reflects pre-SEE conditions in the LSZ only.

d. The document needs to be corrected to reflect that no direct hydrocarbon assimilation or biological degradation rates have been obtained for this site, particularly post-SEE. The only direct microbial data that has been obtained enumerates sulfate-reducing bacteria at the site (pre-SEE) via quantified polymerase chain reaction (qPCR) technology. No attempt to directly prove hydrocarbon assimilation (through stable-isotopes or other such direct methods), or to directly measure biological degradation rates, has been conducted.

3. **Section 2.5, Lines 573-588:**
   a. Provide contaminant maps and temperature gradient maps. As stated in General Comment 4, many of the reported temperatures for this site continue to be significantly above those that are optimal for soil sulfate-reducer survival.
   b. Clarify referred iron state (ferric iron, ferrous iron, etc.). Line 573 claims that elemental iron is a potential TEA, and this is not true. Repeated requests for clarifications as to what form of iron is being referred to (ferric iron, ferrous iron, etc.) have been ignored. This issue occurs throughout the document and should be corrected.
   c. Revise text to reflect that the referenced data does not reflect current site conditions. Line 585 references 18-year old site data that is no longer relevant or scientifically valid, as discussed above.
   d. Lines 587-588: Revise text to reflect that sulfate reducer hydrocarbon biodegradation and population tests have not been conducted. The same 18-year-old data is used to claim that "sulfate-reducing bacteria provide a majority of the naturally occurring assimilative capacity for hydrocarbon degradation at ST012 (BEM, 1998)". This is an erroneous statement, as the ability for hydrocarbon biodegradation, specifically tied to sulfate reducers under current site conditions, has not been tested. Furthermore, the statement that SRB's provide a "majority" of the indigenous hydrocarbon degrading population has never been tested, as no other population has been properly quantified.

4. **Section 3.1.1, Lines 630-631:** Provide evidence (peer-reviewed publications, etc.) that transitioning an aerobic site to a strongly anaerobic site, and then possibly back to aerobic conditions, is a standard procedure for in-situ bioremediation. Lines 630-631 state "Historically, aerobic biodegradation has been demonstrated at the site, especially in wells containing high concentrations of dissolved BTEX+N". If aerobic bioattenuation has been historically demonstrated, it suggests that the site's natural state is aerobic and not strongly anaerobic (such as sulfate-reducing).

5. **Section 3.1.2, Lines 658-663:**
   a. This section states that "sulfate is a TEA that is utilized by microorganisms under anaerobic conditions". This should be revised to more accurately state "sulfate is <u>one of many</u> TEA's that are utilized by microbes under anaerobic conditions". Sulfate-reduction is the only anaerobic process evaluated, despite statements in past documents that other TEAs would be evaluated to determine which is truly dominant at this location. A statement to this effect should be made in the document.
   b. The focus on anaerobic biodegradation disregards the statement in line 630 that "Historically, aerobic biodegradation has been demonstrated at the site, especially in wells containing high concentrations of dissolved BTEX+N". The document should be edited as requested in the previous comment.
   c. The document should be corrected to reflect actual data obtained. In line 663, the claim that sulfate-reduction dominates site biological activity has not been proven. Appendix D of this document clearly states that SRBs make up only 0.48-4.13% of the whole community while anaerobes as a whole make up at least 0.52 – 48.44% of the total microbial community profile.

6. **Section 3.1.3, Lines 690 -691** erroneously claim that SRB make up the dominant indigenous population members when Appendix D data demonstrates that, in fact, they only make up 0.48-4.13% of the whole community. This statement should be corrected.

7. **Section 3.1.3, Line 702:** This statement says that "Oxygen delivered by hydrogen peroxide will remain a consideration in the future, if necessary." Line 630 states that the site is historically known to be aerobic. However, only a deeply anaerobic hydrocarbon degradation process is being proposed. Yet, if this highly anaerobic process does not work, the site geochemistry will be reversed again to promote strongly aerobic systems. This proposition is scientifically invalid at best. This issue has been raised multiple times before, with no response. The document should be edited to provide evidence (peer-reviewed publications, etc.) that transitioning an aerobic site to a strongly anaerobic site, and then possibly back to aerobic conditions is a standard procedure for in-situ bioremediation.

8. **Section 3.3, Line 935:** It should be noted that sulfides will be expected to precipitate, particularly if any form of iron is present. Thus, this statement is more than a "conservative assumption". The document should be edited to reflect that sulfides will be expected to precipitate when iron is present. The document should also be edited to provide a better estimate of Total Dissolved Solids, based on this anticipated precipitation.

9. **Section 4.1.2, Line 1075:** It should be stated that these reported, anticipated temperatures are outside of the normal survivable conditions for soil or groundwater SRBs in this type of environment. The agencies have raised this concern many times before without an acceptable response.

10. **Section 4.2.2, Lines 1129-1142:**
    a. The use of the HACH® BART test in the described manner does not follow standard or accepted protocols. No controls were reportedly performed, and during the August 17, 2017 BCT call, AMEC acknowledged that these tests were performed by a field technician without a background in microbiology. In addition, during this same meeting, AMEC acknowledged that sample temperatures were not maintained and samples were not monitored according to suggested HACH® procedures. As such, data is not reliable. The document should be edited to reflect actual testing conditions as described above, and state that the data may not be reliable.
    b. The temperature of the groundwater used as an inoculum should be included.
    c. Support for extrapolating this data to the entire site should be provided.

11. **Section 4.2.2, Line 1162** states that "Details of specific TEA handling procedures will be included in the EBR SOPs." Please include the relevant SOP in the revised Work Plan.

12. **Section 4.2.3, Lines 1199-1200** states that the described parameters "will be sampled prior to TEA addition." This statement contradicts the first page of the EBR Operational Decision Matrix in Appendix J. All components of the Work Plan – text, tables (including Table 5.1) and appendices (including the Decision Matrix in Appendix J) need to be edited and brought into agreement.

13. **Section 4.2.3, Lines 1208-1210:** The activity of sulfate-reducers, or any bacterial community, cannot be monitored through the technique of qPCR. The only variable that qPCR monitors is the number of copies of a specific, targeted gene in a sample, not activity levels, as not all genes are necessarily active if present. The document needs to be corrected to reflect the correct capabilities and limitations of a qPCR analysis.

14. **Section 4.2.6, Lines 1337-1339:** It is unclear why deliberate inhibition of microbial growth is planned as a way to prevent biofouling. This is not a standard practice, and is contrary to the goal of promoting microbial biodegradation of site contaminants. Please explain why previous suggested methods, such as injecting under pressure, were not planned to be followed.

15. **Section 5.0, Table 5.1:**
    a. PLFA analyses are not a form of stable-isotope (SIP) analyses, but are instead a molecular analysis. The document needs to be corrected to reflect this.
    b. Please include footnotes for notes 1 and 2 that appear in the first column of pages 5-3, 5-5, and 5-6, or remove the notes if they are not applicable.
    c. Add the following wells to the list of Table 5-1 Groundwater/Perimeter monitoring wells and clarify the sampling frequency in Section 5:
        i. CZ08, CZ09, CZ23, CZ25, and CZ24 (as shown on Fig 3-2)
        ii. UWBZ09, UWBZ18, UWBZ38, UWBZ39 (as shown on Figure 3-3)
        iii. LSZ52, LSZ53, LSZ54, LSZ55, LSZ56, LSZ57, LSZ59 (as shown of Figure 3-4)

16. **Section 5.1, Lines 1409-1410:** The text does not match the protocols outlined in Appendix J. Also, see Section 5.1.3, Lines 1440-1441 for another example of this contradictory text versus the Appendix J Decision Matrix. The entire document needs to be revised for consistency, as stated many times in the past and above.

17. **Section 5.4, Lines 1527-1529:** As pointed out initially in the 2016 review of the Draft EBR Work Plan Amendment 2, one month is not an appropriate amount of time for these samplers to be deployed in the subsurface if accurate results are desired. This has been confirmed by communications with Microbial Insights, the manufacturer of the samplers planned for use. Please edit the document to reflect that a scientifically appropriate length of time will be used for sampler deployments.

18. **Section 5.4, Lines 1545 -1553:**
    a. Lines 1547-1549. This statement says that "qPCR conducted on metagenomics extract will be used to detect and quantify (by gene count) the abundance of SRBs and EBAC will be the primary method used to track response." Please clarify this sentence intent.
    b. The quote goes on to say that "the qPCR will target the detection of 16S ribonucleic acid sequences unique to 1) SRBs and 2) EBAC." This is impossible, as the referenced 16S sequence is an RNA molecule, common to all bacteria, and the referenced qPCR technology targets DNA, not RNA. Please correct this statement.
    c. The document then continues to say that "it is recognized that this method excludes archaea; however, bacteria will occupy the majority of activity in the subsurface and provide a surrogate measure for archaea." This is despite repeated claims that methanogens are a key microbial component at this location, and methanogens are part of the archaea organismal group. If methanogens are as significant as claimed, why are they being excluded? This question should be addressed in the document.
    d. Finally, the document states that "in addition, protein extract consisting of PLFAs derived from cell walls will be analyzed to assess the microbial diversity." This comment highlights the belief that there is a misunderstanding of the above-discussed technology, as PLFA molecules are not proteins. PLFA's are phospholipid fatty acid monomers which, together help make the primary cell wall structure of bacteria. Dotted within this PLFA matrix are proteins, but the statement that PLFA molecules are proteins is scientifically false. This statement needs to be corrected for scientific accuracy. The entire document, with particular

attention to the microbial data, should be checked to ensure scientific accuracy and consistency.

19. **Section 5.6, Line 1598:** Status updates need to include actual microbial data. Summary bullets of microbial data are not acceptable due to the repeated, and above-demonstrated, lack of a fundamental understanding of the microbial analyses being performed. Instead, actual data needs to be presented so that the EPA technical team can independently evaluate it and discuss it with the USAF.

20. **Section 5.4.1, Line 1563.** The text states "10 perimeter monitoring wells and 19 select MPE wells/SIWs within the TTZ" will be sampled quarterly. Please revise this statement to match the number of wells identified in Table 5-1, pages 5-4 and 5-5.

21. **Page 6-1, Section 6.2.** Revise the first sentence to read "When the Air Force and the regulatory agencies agree that ~~Once~~ subsurface conditions have met remedial goals for transition to MNA monitoring, the EBR system will be decommissioned and dismantled."

22. **Figures.** Clarify the monitoring status of the "other wells" identified on Figures 3-2 through 3-4. Most of these wells are located in the center of the site and have not been sampled to date. Given the lack of Post-SEE analytical data within the TTZs, these wells should be included for baseline analysis of COCs/COPCs when water temperatures allow safe sampling practices.

23. **Appendix J:**
    a. Appendix J is included to illustrate how data will be evaluated. However, the Decision Matrix directly and repeatedly contradicts statements in the text of this document. The matrix is also no different from that previously presented to the technical team, despite extensive comments and questions from the regulatory agencies. Many of the comments and questions above point out the technical problems contained within the matrix that have gone unaddressed and unchanged. As requested multiple times in the past and in this assessment, the document, in its entirety, needs to be edited such that all inconsistencies are removed. For example, the sequence of events identified in the matrix, particularly in relation to the obtaining of baseline information, does not match the text portion of this document.
    b. Page 1 of the Decision Matrix, blue box, states that iron and manganese will be analyzed. However, the discussion column of this table essentially says that assumptions will be made about the forms of these elements, and thus measuring only elemental forms of these elements will be conducted. This is not scientifically valid. Throughout the matrix and the text of the document, the correct form of iron and manganese should be listed as the metric to be monitored.

Closure

ADEQ may add or amend ADEQ comments if evidence to the contrary of our understanding is discovered; if received information is determined to be inaccurate; if any condition was unknown to ADEQ at the time this document was submitted or electronically delivered; if other parties bring valid and proven concerns to our attention; or site conditions are deemed not protective of human health and the environment within the scope of this Department.

Thank you for the opportunity to comment. Should you have any questions regarding this correspondence, please contact me by phone at (602) 771-4121 or e-mail miller.wayne@azdeq.gov.

Sincerely,
Wayne Miller
ADEQ Project Manager, Federal Projects Unit
Remedial Projects Section, Waste Programs Division

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